EE 701 Flexible AC Transmission Systems (FACTS)

Unit-1: Introduction: Facts basic concepts and general system considerations, power flow in ac system, definitions on facts, basic types of facts controllers, benefits from facts Technology, static var compensator (SVC): principle of operation and control strategy, thyristor controlled phase angle regulator (TCPAR): principle of operation and control strategy.

Unit-2: Transient Stability Analysis: Analysis of Power systems installed with FACTS devices.
Control with FACTS: Power Transmission Control using UPFC, power transmission control using phase shifting transformer (PST), power transmission control using SSSC.

Unit-3: **Oscillation Stability Analysis and Control with FACTS**: Linearised model of power systems installed with FACTS based stabilizers, Heffron-Phillips model of a SMIB system installed with SVC, TCSC and TCPS, Heffron-Phillips model of a SMIB system with UPFC, Heffron-Phillips model of a multi-machine system installed with SVC, TCSC and TCPS.

Unit-4: **Design of FACTS based stabilizers**: Analysis of damping torque contribution by FACTS based stabilizers installed in SMIB systems, selection of installing locations and feedback signal for FACTS based stabilizers, Dynamic Voltage restorer.

Unit-5: Power flow Controller: Unified Power Flow Controller (UPFC), principle of operation, configuration and control, simulation of UPFC, steady state model of UPFC, interline power flow controller (IPFC), principle of operation, configuration and control, static compensator (STATCOM), principle of operation and control, application for mitigation of SSR.

References:
1. "Understanding FACTS Devices" N.G. Hingorani and L. Guygi. IEEE Press Publications 2000.
2. Flexible AC Transmission System: Y.H.Song and A.T.Jhons, IEE, 1996(A Book)
3. Dr Ashok S & K S Suresh Kumar "FACTS Controllers and applications" course book for STTP, 2003.
4. Ned Mohan et.al, Power Electronics, John Wiley and Sons.
5. K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International, First Edition.

EE- 702 Control Systems

Unit I - Introduction to Control System & Classification : Differential equations of systems, linear approximation, laplace transform and transfer function of linear system, model of physical system (electrical, mechanical and electromechanical), block diagram, signal flow graph, mason's gain formula, return difference and return ratio, error detectors, servomotor, tachogenerator, servo amplifier , magnetic amplifier, rotating amplifier.

Unit II - Time Domain Analysis: Representation of deterministic signals, first order system response, s- plane root location and transient response, impulse and step response of second order systems, performance characteristics in the time domain, effects of derivative and integral control, steady state response, error constant, generalized definition of error coefficients, concepts of stability, Routh Hurtwitz criterion.

Unit III - Frequency Domain Analysis: Frequency response bode plot, polar plot, nicol's chart, closed loop frequency response, frequency domain performance characteristics, and stability in the frequency domain, nyquist criterion.

Unit IV - Root Locus Method: Basis theory and properties of root loci, procedure for the construction of root loci, complete root locus diagram, design and compensation of feed back control system, approaches to compensation, cascade compensation networks and their design in the frequency domain, simple design in s- plane.

Unit V - State Variable Methods: Introduction to state variable concepts, state variable description of linear dynamic systems, representation in matrix forms, block diagram and signal flow graph representation of state equations – transfer matrix from state equations, transition matrix, general solution for linear time invariant state equations, basic principles of adaptive control systems.

References:

1. Ogata K, "Modern Control Engineering ", Prentice Hall
2. Modern Control Engineering,B S Mankey
3. Nagarath & Gopal," Control System Engineering," Wiley Eastern
4. Bakshi & Goyal. Feedback control system, Technical publication.

List of Experiment (Extendable):

1. To determine speed torque characteristics of armature controlled D.C. servomotor.
2. To determine the speed torque characteristics and relationship between torque speed and control windings voltage by AC servomotor.
3. To obtain the step response transient characteristics of first order electric system and to measure system parameters.
4. To plot the nyquist plot of a given transformer function using matlab.
5. To plot the bode plot of a given transformer function using matlab.

EE- 703 Electrical Drives

Unit I- Introduction to Electric Drives: Elements of drive systems, requirement of electric drives, rating & selection of drives, groups and individual drives, constant power and constant torque drives. Review of characteristics of AC & DC motors, load torque, load-drive, speed torque characteristics, quadrant speed torque characteristics, load equalization, stability of electric drives, moment of inertia and torque of motor load combination.

Unit II-DC Drives: Starting, braking, transient & steady state analysis phase controlled and chopper controlled drives, speed control, energy recovery systems, dual converter.

Unit III- Induction Motor Drives: Starting braking and speed control, PWM, voltage source inverter and current sources fed im drives, cyclo converter fed drive, vector control drives, slip power recovery, conventional control methods, rotor impedance control, converter controlled-Static Scherbius & Static Krammers drives.

Unit IV- Synchronous Motors Drives: Starting, braking, transient analysis, synchronous motors variable speed drives, V/F control, cyclo converter fed synchronous motor drive.

Unit V- Special Motor Drives: Fundamentals of switched reluctance motors, stepper motors, permanent magnet motor, vector control, digital control of drives.
Traction: Electric traction, machine tool drive, electric cars, steel & cements plants, textile & paper mills.

References:

1. G.K. Dubey "Fundamentals of Electrical Drives"-. Narosa Publications
2. 2. Gopal K. Dubey "Power semiconductor Controlled Drives"- PHI
3. S.K. Pillai, "A first course of Electrical Drive" New age International.
4. Ned Mohan Electrical Drive Wiley India
5. V. Subramanyam "Thyristor control of Electric Drive" Tata Mc Graw Hill Pub.
6. S.Shiva Nagaraju power semiconductor drive PHI learning

List of Experiments:

1. To study the starting and running characteristics of converter fed DC traction motor.
2. To study the energy recovery systems and braking of a DC drive.
3. To study the braking methods of a three-phase induction motor.
4. To study the performance of VSI fed three-phase induction motor using PWM technique.
5. To control the speed of a three phase slip ring Induction motor using rotor impedance control.
6. To study the performance of Vector Controlled three phase Induction motor drive.
7. To Study frequency Controlled Synchronous motor drive.

(Elective-I) EE- 704 [A] - High Voltage Engineering

Unit –I Introduction: Basics of HV technology, advantages of transmitting electrical power at high voltages, need for generating high voltages in laboratory, applications of high voltage.

Unit –II Insulation & Breakdown: Classification of HV insulating media, its properties, gaseous dielectrics, ionizations, Townsend's theory & its limitations, streamer's theory breakdown in non uniform fields, corona discharges, Paschen's law and its significance, time lags of breakdown, breakdown in solid dielectrics, intrinsic breakdown, avalanche breakdown, thermal breakdown, and electro mechanic breakdown, breakdown of liquids dielectric, suspended particle theory, electronic breakdown, electro convection breakdown, cavity breakdown (bubble's theory).

Unit –III High Voltage AC DC : HV AC transformer, need for cascade connection, working of transformers units connected in cascade, series resonant circuit, principle of operation and advantages, tesla coil, HV DC voltage doubler circuit, Cock Croft- Walton type high voltage DC set.

Unit –IV: Impulse Voltage and current Introduction to standard lightning and switching impulse voltages, analysis of single stage impulse generator, expression for output impulse voltage, multistage impulse generator, its components, triggering of impulse generator by three electrode gap arrangement, triggering gap, oscillograph time sweep circuits, generation of switching impulse voltage, generation of high impulse current.

Unit –IV High Voltage Tests on Electrical Apparatus: Definitions of technologies, tests on isolators, circuit breakers, cables insulators and transformers.

Unit –V Measurement of High Voltages: Electrostatic voltmeter, generating voltmeter, series resistance micro ammeter, HV DC measurements, standard sphere gap measurements of HV AC & HV DC, potential dividers, resistance dividers, capacitance dividers, mixed RC potential dividers, surge current measurement.

References:

1. E. Kuffel and W.S. Zaengl, "High voltage engineering fundamentals", 2nd edition, Elsevier, press, 2005.
2. M.S.Naidu and Kamaraju, "High Voltage Engineering", 3rd edition, THM, 2007.
3. L. L. Alston, "High Voltage technology", BSB Publication, 2007..
4. Rakosh Das Begamudre, Extra High voltage AC transmission engineering, Wiley Easternlimited, 1987.
5. Transmission and distribution reference book-Westing House.
6. C.L.Wadhwa, High voltage engineering, New Age International Private limited, 1995.

EE- 704[B] - Generalised Theory of Electrical Machines

Unit I Generalized Theory: Conversions, basic two pole machines, transformer with movable secondary, transformer voltage and speed voltage, Kron's primitive machine , analysis of electrical machines, voltage and torque equation.

Unit II Linear Transformations: Invariance of power, transformations from displaced brush axis, three phases to two phase, rotating axes to stationary axes, transformed impedance matrix, torque calculations.

Unit III DC Machines: Generalized representation, generator and motor operation, operation with displaced brushes, steady state and transient analysis, sudden short circuit, sudden application of inertia load ,electric braking of dc motors.

Unit IV Synchronous Machines: Generalized representation, equivalent circuit, steady state analysis, transient analysis , phasor diagrams, electromechanical transients.
Induction Machines: Generalized representation, performance equation, equivalent circuit, steady state analysis, transient analysis, phasor diagrams, double cage machine, harmonics, voltage & torque equation for steady state operation of induction motor & Scharge motor.

Unit V Special Machines: Generalized representation, steady state analysis of reluctance motor, brushless dc motor, variable reluctance motor & single phase series motor.

References:

1. P.C.Krause, Analysis of Electric Machinery, Wiley India.
2. B.Adkins, The General theory of Electrical Machines.
3. B.Adkins & R.G.Harley, The General theory of AC Machines.
4. P.S.Bhimbra, Generalised theory of Electrical m/c
5. White & Woodson, Electro Mechanical Energy Conversion.

EE- 705[A] - Computer Aided Design of Electrical Machines

Unit-I Computer Aided Design Philosophy of computer aided design, advantages, limitations, analysis and synthesis methods, selection of input data and design variables, flow charts for design of induction motor and synchronous machine, optimization of design constrained and unconstrained optimization problem

Unit-II DC machine:-Design of armature windings & field systems, selection of variables for optimal design, formulation of design equations, objective function, constraint functions, algorithms for optimal design.

Unit-III Power Transformer:-Design of magnetic circuit, design of windings, selection of variables for optimal design, formulation of design equations, objective function, constraint functions, algorithms for optimal design.

Unit-IV Single Phase Induction Motor-Calculation of main dimensions of stator, complete design of stator with its punching details, design of main and auxiliary winding, design of rotor, performance calculation of designed rotor and performance by equivalent circuit approach.
Three Phase Induction Motor -Design of stator, windings design of squirrel cage rotor, design of slip ring rotor, selection of variables for optimal design, formulation of design equations, objective functions constraint functions, algorithms for optimal design.

Unit-V 3-Phase Alternator:-Design of stator, windings, design of field systems for salient pole and non-salient pole machines, selection of variables for optimal design, formulation of design equations, objective function, constraint functions, algorithms for optimal design.

References:

1. Computer- Aided Design of Electrical Equipment- by Dr. M. Ramamoorthy-Affiliated East-West press Pvt. Ltd. New Delhi.
2. Electrical Machine Design- by A.K. Sawhney, Dhanpat Rai & Sons.
3. Performance and Design of A.C. Machines-M.G. Say, Affiliated East West Press Pvt. Ltd., New Delhi.
4. Performance and Design of D.C. Machines- Clayton & Hancock.
5. Principles of Electrical Machine Design with Computer Programmes by- S.K. Sen, Oxford & IBH Publishing Co.

EE- 705[B] - Artificial Intelligence

Unit 01: Introduction: Organization of the brain, biological neuron, biological and artificial neuron models, historical developments, essentials of artificial neural networks, artificial neuron model, operations of artificial neuron, types of neuron activation function, ANN architectures

Unit 02: Classification Taxonomy of ANN: Connectivity, neural dynamics (activation and synaptic), learning strategy (supervised, unsupervised, reinforcement), learning rules. perceptron models: training algorithms: discrete and continuous perceptron networks, perceptron convergence theorem. multilayer feed forward neural networks

Unit 03: Memory: Associative memory, bi-directional associative memory, architecture, BAM training algorithms, storage and recall algorithm, BAM energy function, self-organizing maps (SOM) and adaptive resonance theory (ART).

Unit 04: Fuzzy Logic system: Fuzzy versus crisp, fuzzy sets, membership function, basic fuzzy set operations, properties of fuzzy sets, fuzzy relations, fuzzy control**,** predicate logic (interpretation of predicate logic formula, inference in predicate logic), fuzzy logic (fuzzy quantifiers, fuzzy inference), fuzzy rule based system, defuzzification methods.

Unit 05: Intelligent Tools: Introduction to genetic algorithm, biological background, GA operators, selection, encoding, crossover, mutation, chromosome, expert system, software architecture, rule base system.

References:

1. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Edition, Pearson Education
2. S. Rajsekaram, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis & Applications", Practice Hall India
3. James A. Anderson, "An Introduction to Neural Networks", Practice Hall India Publication
4. Mohamed H. Hassoun, "Fundamentals of Artificial Neural Network", Practice Hall
5. Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, "AI Techniques in Power System", IEE London U.K.
6. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Network Using MATLAB 6.0", Tata McGraw Hill.

EE-706 Major Project Synopsis-I

The students have to keep in mind that in final semester they would be required to implement whatever has been planned in the **Major Project Synopsis-I** in this semester. It is possible that a work, which involves greater efforts and time may be taken up at this stage and finally completed in final semester, but partial completion report should be submitted in this semester and also evaluated by an external examiner. At the end of semester, all students are required to submit a synopsis.

EE-707 Industrial Training –I

Duration: 2 weeks after the VI semester in the summer break, Assessment in VII semester.

Students must observe following to enrich their learning during industrial training:

- Industrial environment and work culture.
- Organisational structure and inter personal communication.
- Machines/ equipment/ instruments - their working and specifications.
- Product development procedures and phases.
- Project planning, monitoring and control.
- Quality control and assurance.
- Maintenance system.
- Costing system.
- Stores and purchase systems.
- Roles and responsibilities of different categories of personnel.
- Customer services.
-Problems related to various areas of Work etc.
- Layout if any